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JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

FALLS OF COAL AND ROCK ON MAN-TRIPS IN BITUMINOUS-COAL MINES

BY

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FALLS OF COAL AND ROCK ON MAN-TRIPS IN BITUMINOUS-COAL MINES[1]

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INTRODUCTION

A few of the more progressive mining companies have taken precautions to safeguard employees on man-trips. Specially constructed man-cars have been provided with special devices or mechanisms to stop the cars on slopes, if the hoisting cable should break. Cars have been equipped with safety chains to connect and hold them together if a coupling should break. Steel frames covered with heavy wire netting have been placed over cars to reduce injuries to the riders from roof falls on slopes. A safety cable passing from the front car to a point above the cable socket on the slope hoisting cable is used frequently as a precaution in case the socket loosens or the main cable breaks at the socket.

Such devices are commendable, but the percentage of man-cars and man-trips protected is relatively small - entirely too small. Man-trips that travel level haulage roads are rarely protected with safety devices, and haulage roads are seldom inspected by mine officials to determine the condition of roof and ribs.

During the past few years several accidents in bituminous-coal mines have resulted in death and serious injury to men riding on man-trips. Officials investigating such accidents have tended to classify them as "acts of God", ignoring the possibilities of human failure. Such accidents are regrettable, and circumstances often indicate carelessness, ignorance, or both. It is believed that each accident can be a lesson in accident prevention; this circular therefore describes a number of accidents and indicates probable causes and ways of preventing similar ones.

DETAILS OF ACCIDENTS

1. Fall of Roof on Man-trip

A fall of roof on a man-trip killed 3 miners and injured 8 others. The coal bed, which averages 90 inches in thickness, is overlain by a gray shale of variable character. In some parts of the mine the shale is massive, comparatively soft, and streaked with cracks and "slips" or so-called "cutters" running in different directions. The accident occurred on the main entry where the track turned into a parallel entry. When the man-trip reached this point it pulled into the crossover and stopped. Three or 4 minutes later a piece of roof approximately 19 feet long, a maximum of 8 feet wide, and 1 foot thick fell from the roof, covering the fifth car from the locomotive and falling partly on the fourth and sixth. A man in the fifth car, noticing a small piece of shale fall from the roof, jumped into the sixth car just before the large piece of roof fell and was uninjured. The rock did not break but "bridged" across the tops of the cars. Three men in the fifth car were killed instantly, each receiving a fracture of the spine. Three other men were seriously injured; one received fractured ribs, another a punctured lung, and the third a fractured pelvis. Five others were injured but less seriously.

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[1] The Bureau of Mines will welcome reprinting of this information circular, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6863."

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Some of the factors contributing to this accident were:

1. The man-trip had been stopping at this point every morning for several days so the men could get out of the trip, yet the mine officials had failed to test the roof or in testing it either had not detected its loose condition or had detected it but had failed to make it safe.

2. The management failed to provide a suitable place for the men to unload from the man-trip.

3. Ten or 12 men were allowed to ride in each car, overcrowding it, which in this instance resulted in the injury of a larger number of men and perhaps added to the severity of the injuries because the men could not move freely.

This accident illustrates a practice common in some coal mines of neglecting to test roof on haulage roads. State laws usually have provisions that require the operating company, through the mine foreman or his assistant, keep travelways, haulage roads, and working places in safe condition. Unfortunately mine officials are usually so anxious to arrive early at the working places that they ride on the locomotives or in empty cars to the sections, where they remain as long as possible and then ride out. If the mine foreman cannot walk along the haulage roads each day he should assign this duty to an assistant; at any rate the roof and sides of haulage roads should be given much more effective supervision than in most mines.

Another lesson to be gained from this accident is that overcrowding man-cars may result disastrously. When men ride on both sides of man-cars they do not have room to avoid falling rock or coal. The fact that the 3 men killed received fractured spines, that 1 man suffered fractured ribs, and that another received a broken pelvis indicates that because the cars were crowded those in the car on which the roof fell were unable to throw themselves on the floor or to jump from the car and hence received serious injuries from direct blows. The rock did not break and fall into the car in this instance, and if the men could have thrown themselves to the bottom of the car they might have been uninjured or only slightly injured.

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Overcrowding cars increases the number of men exposed to falls of rock or coal by increasing the number in a restricted area. Five or 6 instead of 10 or 12 men would have been exposed in this instance if the men had been required to ride on one side of the car only; likewise the number and probably the severity of the injuries would have been decreased. The fact that one man was able to escape injury by jumping from one car to another indicates that the others might have been injured less severely if they had had enough room to move freely.

Moreover, men should not be permitted to ride under the trolley wire, as this constitutes a shock hazard.

2. Falls of Rib on Man-trip

Two men were killed and 3 injured by a fall of rib coal and overhanging rock while a man-trip of 5 cars with 2 to 5 men to a car was waiting at a sidetrack for orders to proceed into the mine.

The coal bed averages 3 feet 5 inches in thickness; to obtain adequate height on haulage roads the fireclay bottom had been removed to a depth of 18 to 24 inches. Several years ago the roof had fallen to a height of about 13 feet at the site of the accident. The roof in general is hard gray shale which requires only limited timbering. The coal is overlain by a stratum of cannel coal or so-called "shale" which has a cubical fracture with numerous slips or cracks along the fracture planes. The immediate dark-gray shale roof had cracks corresponding to those in the cannel coal. At the site of the accident the rock above the dark shale dipped at a sharp angle behind the shale, and the contact between the two shales had a "slick" coating.

Fireclay is said to expand when first exposed and then as it absorbs moisture to disintegrate and crumble. It is believed that the fireclay expanded and that the extra pressure exerted on the overlying coal and rock caused cracks. Later the fireclay crumbled and fell, leaving the coal unsupported for about 6 inches at the bottom and for as much as 2 feet near the roof. As the entry at the sidetrack was 18 feet wide and the edge of the fall only 9 feet from a crosscut the roof may have exerted extra pressure, and the constant vibration of passing trips may have loosened the rib gradually. A loaded trip had passed about a minute before the fall occurred.

The fall of coal and rock from the rib gave only slight if any warning. The piece that fell was about 11 feet long, 8 feet high, and 6 to 24 inches thick. The fourth man in the second car received only a scratch on his finger; the fifth man received a fractured skull when a rock about 3 feet long, 12 to 18 inches wide, and 12 inches thick fell from the upper part of the rib and hit his head, knocking it forward against the iron brace on the opposite side of the car. The first man in the third car was hit on the back and sustained a fractured pelvis and foot. The second man was knocked against the opposite side of the car and received a broken pelvis, punctured bladder, and other internal injuries that caused his death. The third man's back was broken. The fourth man was held in his seat by the fallen material which fractured his spine and caused contusions and bruises from which he died. The men in the other cars were uninjured.

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The injured were taken from under the rock and coal, given first-aid treatment, and hauled to the surface.

Failure to test the roof and ribs along the haulage road, especially at the sidetrack where it was customary for the man-trip to stop, was largely responsible for this accident.

Roof and ribs on haulage roads and travelways should be inspected and tested daily or at least twice a week. Tests should be made immediately before the beginning of each shift wherever roof has fallen and coal or rock overhangs main entries or travel roads.

Posts with blocks or lagging between post and rib should be set along the rib at man-trip stops to prevent material from falling and injuring the men. Loose roof should be taken down and if doubtful should be supported.

3. Fall of Roof on Moving Man-trip

A fall of roof on a moving man-trip injured more or less severely 10 of 11 men riding in one car. The company has adopted a number of safe practices to safeguard men riding on man-trips; each man-trip is hauled by a locomotive operated by the section foreman. However, the cars were overcrowded with as many as 11 or 12 men in a car; consequently the men were forced to ride on the side under the trolley wire as well as on the side free of the trolley-wire menace.

The coal bed averages 5½ feet in thickness; the draw slate is overlying the bed 6 to 12 inches thick and must be taken down during mining of the coal. A stratum of coal about 8 to 12 inches thick is left to keep air and moisture from the overlying strata of several inches of draw slate, carbonaceous shale, and gray calcareous shale. The management believes that as long as the roof coal remains in place, although sagging or sounding "drummy" when tested, the roof is good and will stay in place. Considerable timbering is required along the haulage road, and the method of setting timbers is good.

The night crew in one section had completed its shift, and about 20 men entered 2 cars, 11 men seating themselves in the first car. The section foreman took his position on the locomotive and started out of the mine. They had gone only a short distance when the foreman saw pieces of roof falling. He opened the controller to the last notch, and the cars jerked forward violently and threw the men sidewise toward the rear of the cars. At about the same time the roof fell, mainly from the right rib; the men riding on that side of the car were less severely injured than those on the opposite side. It was impossible to determine from the investigation whether the roof was all coal at this point and whether the coal and rock in the middle of the entry had fallen earlier or had been in place. Apparently only overhanging material at the roof on the rib was in place and had fallen. The largest piece of rock measured 7 feet 2 inches long, 2 feet 8 inches wide at the widest point, and from about 7 inches in the center to feather edges on all sides. The upper surface was rounded and smooth or "slick."

At the time of the investigation most of the fallen material had been removed, and loose overhead rock had been taken down; the rock on the opposite rib was loose, and the coal roof for about 100 feet outby the scene of the fall was in place but was decidedly "drummy" and vibrated readily when tested with a heavy piece of iron. In several places part of the coal roof was sagging more than an inch in the center of the entry. Previous experience in this mine led the officials to believe that this coal roof was safe. Each day a timberman travels through this entry, and whenever he finds loose or "bad" roof he removes it and sets crossbars; "drummy" and loose coal is often left in place.

This accident occurred during the hot summer months, and the excessive moisture deposited on the roof at the edge of cavities undoubtedly accelerated the deterioration of the calcareous roof rock. Failure to place a crossbar under the edge of coal roof after the roof has fallen probably allows the coal to break loose from the roof rock and moisture to enter, causing the rock to disintegrate, crack, and ultimately break the underlying layer of roof coal.

The belief that as long as coal is in place the roof rock will not fall is undoubtedly erroneous, and this contributed directly to the injury of the 10 men in this instance.

Here, again, overcrowding of the man-trip was responsible for injury to about twice as many men as would have been injured if the men had been required to sit only on the side of the car opposite the trolley wire. By forcing the trolley wire down on the injured men and on the men in the second car the fall easily might have resulted in one or more electrocutions and severe burns.

The lessons to be learned from this occurrence are:

1. All loose and "drummy" roof, especially on haulage roads, should be taken down.

2. When roof is taken down or if roof falls occur two or more crossbars should be placed close together at the edge of the coal roof on each side of the fall.

3. The man who inspects the roof on haulage roads should be instructed to report to the mine foreman all doubtful as well as loose roof.

4. Men should be required to ride on the side of the man-car opposite the trolley wire.

5. All persons, including officials and visitors, should be required to wear hard hats while underground.

SAFEGUARDING MAN-TRIPS

In many mines no precautions are taken to reduce roof falls on haulage roads even after accidents from falling material have resulted in injury to persons on man-trips. The accidents discussed in this circular in virtually every instance were classified as "unavoidable", and few if any precautions were taken to prevent recurrence of similar accidents insofar as could be determined by later investigation. The engineers of the United States Bureau of Mines believe that definite lessons may be learned from each accident and that a large number of accidents from falls of rock and coal on man-trips can be prevented if information is disseminated, especially if the precautions are taken as pointed out to the mining industry.

After a fall of roof coal which killed 1 man and injured 6 others on a man-trip a coal-mine operator in the mid-West required men to go ahead of the man-trip to examine the roof along the roadway. The roof, overhanging rock, and ribs along haulage roads should be tested by the vibration method as well as by the usual sounding method at least once a day before the major shift starts; a competent, reliable employee should be assigned to this job. Any defective or dangerous condition of roof or rib on haulage roads should be remedied promptly.

Roof coal and overhanging rock on ribs at sidetracks, turn-outs, or other places where man-trips stop frequently should be examined and tested before the beginning and end of each shift on which man-trips are run. Failure of roof or coal for a time to fall should not be accepted as evidence of roof stability.

With certain exceptions roof coal should be considered temporary support. It may be left in place in rooms where the coal is extracted in a relatively short time, but on entries it should be taken down unless special roof conditions make removal undesirable. The belief in certain coal-mining districts that coal or other roof is safe even when "drummy" and vibrating under tests has led directly to numerous fatalities and other injuries from falling roof. The rule "if roof is loose take it down, if doubtful or difficult to take down timber it" should not be waived unless special conditions exist.

Wherever the entry roof is taken down the roof at the entrance to rooms should be supported by two or more crossbars placed about 6 to 12 inches apart. If roof is taken down or if a fall occurs on an entry the same method of support should be used on each side of the roof cavity. Roof coal that is not too weak may be held in place for a time by timbering before it has an opportunity to loosen. However, taking down roof coal is the best policy in most mines.

Man-cars should not be overcrowded, and men should be required to sit on the side of the car opposite the trolley and other power wires. This practice reduces the electric-shock hazard, reduces the number of men exposed to falls of rock and coal on man-trips by reducing the number in each car, and it may reduce the severity of injuries or prevent injuries by allowing men more freedom to move and dodge falling material.

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The rib and roof at man-trip stops should be made safe by setting posts about 3 feet apart. The posts should have substantial cappieces, and blocks should be placed between posts and rib to prevent rib material from rolling over onto the man-trip.

Men should be required to wear hard hats while underground, including the time while riding on man-trips. The number and severity of injuries received by some of the men in the accidents described might have been greatly reduced if they had worn hard hats.

Investigations of roof-fall accidents indicate that in many mines, especially those east of the Mississippi River, most falls of roof on entries occur during the hot summer months when the intake air has a high moisture content. The relatively cool temperature of the coal and rock surfaces underground causes the moisture to be deposited on the roof and ribs and in the layers of roof exposed in cavities. Several means of preventing deposition of moisture in mine-roof cavities have been developed, but one of the most promising appears to be a method developed in the mid-West. In a section of one intake air course where water was falling in a number of small streams it was observed that the roof was stable, whereas in other air courses a number of falls occurred during the summer months. Assuming that the water "screen" was a definite factor in reducing falls, a water spray was installed at the foot of the intake air shaft. The results were encouraging, and falls of roof were greatly decreased probably because the water spray reduced the dew-point temperature as well as the daily variation in temperature and thereby decreased the action of moisture and temperature on the roof materials. This method could be adopted with profit in many coal mines.

The number of persons injured on man-trips apparently is increasing. The adoption of the precautions suggested in this circular, in addition to other widely used safeguards, should reduce the hazards from material falling on men riding to and from work on man-trips.